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(54) Title: IMPROVED HERBICIDE FORMULATIONS AND THEIR USE

(57) Abstract

A herbicidal composition comprising a herbicidally effective amount of an agriculturally acceptable herbicide, humectant, and silicone surfactant optionally with inert adjuvants and water. A herbicidal method of use for killing and controlling weeds is also disclosed.

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IMPROVED HERBICIDE FORMULATIONS AND THEIR USE

BACKGROUND

This application is a continuation-in-part of co-pending application USSN 07/206,405 filed June 14, 1988.

This invention relates to a method and composition for enhancing the efficacy of herbicides in particular herbicides selected from the group consisting of acifluorfen, its agriculturally acceptable salts, oxyfluorfen, lactofen, imazaquin acid and the agriculturally acceptable salts thereof, N-phosphonomethylglycine and its agriculturally acceptable salts thereof, mixtures thereof and the like.

This invention also relates to a ready to use composition comprising an enhanced delivery system for herbicides.

Herbicides may be applied to plants in a variety of methods including different formulations. Of these various methods, use of liquid and dry compositions are quite desirable. The particular formulation desired and resulting efficacy enhancement will greatly depend upon the weed species to be treated, environmental conditions, the geographical area and the climatology of the area at the time of treatment.

In many areas of the world, it is highly desirable to apply a herbicide composition having rainfastness quality (adherence to foliage) in areas of high rainfall amounts or under conditions and timing where rainfall is highly likely following application of a herbicide. Further in some areas, it may be particularly desirable to apply herbicide compositions (typically a herbicidal composition) to vegetation which has a thick cuticle and therefore herbicide penetration may be somewhat inhibited.

Use of compositions of this invention produced increased herbicide efficacy particularly in applications of a herbicide in accordance with this invention on rhizome johnsongrass, a narrowleaf perennial, and seedling johnsongrass, barnyardgrass and downy brome which are narrlowleaf annuals.

Glyphosate (N-phosphonomethylglycine) is well known as a foliage-acting herbicide. In the free acid form, glyphosate has low water solubility, and because of this, commercial formulations contain a water-soluble salt of glyphosate. For example, in Roundup® herbicide, sold as a concentrate, glyphosate is formulated as the isopropylamine salt.

U.S. Patents 3,799,758 issued to John E. Franz on March 26, 1974 and 4,405,531 issued on September 20, 1983 disclose derivatives of N-phosphonomethylglycine and the use of N-phosphonomethylglycine, its salts and derivatives thereof as herbicides and herbicidal compositions thereof. U.S. Patent 4,315,765 issued to George B. Large on March 15, 1983 discloses trimethylsulfonium and trimethylsulfoxonium salts of N-phosphonomethylglycine

and their use as herbicides and herbicidal compositions. Iminourea and substituted iminourea salts such as guanidine and aminoguanidine salts of N-phosphonomethylglycine are also examples of known herbicides.

The use of humectants with certain herbicides is disclosed in "Additives in Herbicide Formulations", Andress G. Kanallopoulos, Sandos, Ltd. Agrochemical Department Switzerland Chemistry and Industry, 7 December 1974, which discloses on page 352 that humectants improve penetration of herbicides into plant leaves by preventing drying of spray deposit, thereby increasing the penetration time. This article discloses that glycerol has been used as a humectant with 2,4-D and other herbicides. Other glycols disclosed are ethylene and propylene glycol, and polyhdric alcohols in mixtures with free fatty acids and DMSO. Polymeric compounds are reported to be humectants which according to this article includes Carbowax, sucrose, molasses and polypropylenediol.

In *Comparison of Urea Foliar Sprays Containing Hydrocarbon or Silicone Surfactants with Soil Applied Nitrogen in Maintaining the Leaf Nitrogen Concentration of Prune Trees,* D.R. LEECE et. al. J. Amer. Soc. Hor Sci.104(5):644-648 1979 discloses use of a nonionic silicone surfactant, L-77 (organosilicone block copolymer - Union Carbide New York, the nonionic hydrocarbon surfactant (X-77), and free fatty acid and isopropanol with the humectant glycerol in urea fertilizer foliar sprays on prune trees. Compositions and use are also disclosed for glycerol and L-77 in this article.

Monsanto sells Roundup herbicide EPA Registration No. 524-308-AA (label booklet 1987-4) which is a commercial formulation of the isopropylamine salt of N-phosphonomethylglycine also containing an ethoxylated amine surfactant, inert adjuvants and water.

The use of an organosilicone surfactant, such as Silwet L-77 in tank mixes with commercially purchased Roundup® herbicide at time improves the rainfastness of the resulting formulation of Roundup on some species of weeds. However, Silwet L-77 is antagonistic to Roundup herbicide in such tank mixes with Roundup herbicide when rainfall does not occur after a Roundup composition containing Silwet L-77 (without added humectant) has been applied to many plants, particularly on narrowleaf species.

Monsanto sells "Pulse" penetrant (which is L-77) for use with Roundup herbicide and discloses on the Pulse label that the addition of Pulse can reduce the rainfree period for Roundup herbicide from 4-6 hours to 2 hours on perennial ryegrass when label recommended rates of Roundup herbicide and Pulse are sprayed on dry foliage.

Stauffer Australian Patent Application AU-A-64552/86 published May 7, 1987 discloses herbicide compositions comprising (a) an herbicidally effective amount of an agriculturally acceptable salt of N-phosphonomethylglycine, (b) at least one humectant having a moisture capacity substantially equivalent to that of sorbitol; (c) inert adjuvants; and (d) water; wherein the ratio of (a) to (b) ranges from about 1:33 to about 5:1 by weight. A herbicidal method of use of such compositions is also disclosed.

Further, at page 3, this published patent application discloses that suitable humectants can be employed to keep a salt of N-phosphonomethylglycine moist over a longer period of time on the foliage of plants, thereby enabling it to be absorbed into the foliage in a greater quantity and at a higher rate than would otherwise be possible.

L. L. Jansen, "Enhancement of Herbicides by Silicone Surfactants" Volume 21, Issue 2 (March) 1973, *WEED SCIENCE*, discloses that in a comparative evaluation of adjuvant effects in eight species, nonionic silicone glycol surfactants enhanced the activity of six herbicides to a greater extent than a standard organic surfactant, whereas cationic amino silicone surfactants enhanced to a lesser extent.

Great Britain Patent Number 1,225,249 to Dow Corning Corporation, published December 1, 1971, discloses herbicide compositions employing silicone glycol copolymers. Here, general utility of a large number of adjuvants is professed, as exemplified by two generic silicone glycol formulas which embrace structures having both diorganosiloxane units and alkyl-glycol siloxane units. There is also provided a wide-ranging list of suitable herbicides. This reference, however, provides little direction to those skilled in the art as to which particular silicone glycol structures are to be advantageously combined with specific herbicides, save for two examples employing a triazine herbicide in conjunction with an adjuvant having 1.8 siloxy units and bearing a glycol chain having 12 ethylene oxide units.

In addition to the herbicidal enhancement provided by the activity-increasing adjuvants

discussed above, it is often important that herbicide formulations retain a significant degree of activity when plants treated therewith are exposed to rain shortly after application, this being a definition of the degree of "rainfastness." This is particularly important for water-soluble foliar-applied herbicides, such as glyphosate salts.

While prior art tank mix formulations of Roundup have included added glycol humectants, or have included Silwet L-77 without added glycerol, a need exists for a formulation of N-phosphonomethylglycine or an agriculturally acceptable salt thereof or mixtures thereof which will provide the advantages of using an organosilicone such as Silwet L-77 without antagonism toward the N-phosphonomethylglycine based herbicide under both rainfall and no rainfall conditions following application of a composition of this invention to plant foliage.

OBJECTS

It is an object of the invention to provide an agriculturally acceptable herbicidal composition having improved efficacy particularly for herbicidal compositions comprising herbicide, inert adjuvant(s), water, humectant, and silicone surfactant.

It is another object of the invention to provide a glyphosate herbicidal composition having improved efficacy under rainfall or no rainfall conditions with less antagonism toward the herbicide active ingredient than when a silicone surfactant is present in the formulation.

It is yet another object of the invention to provide a delivery system for enhancing the efficacy of herbicidal compositions containing a herbicide.

It is yet an additional object of the invention to make a herbicide more effective in maintaining contact with the locus of application, e.g., on the plant foliage.

It is still yet another object of the invention to provide a herbicidal composition comprising an efficacy increasing amount of a humectant and silicone surfactant.

It is yet an additional object of this invention to provide a herbicidal method of use of such compositions as described above.

SUMMARY OF THE INVENTION

The above and other objects are met in this invention which provides a novel method and composition for enhancing the efficacy of herbicides, in particular foliar applied herbicides more in particular herbicides selected from the group consisting of acifluorfen (5-(2-chloro-ααα-trifluoro-p-tolyloxy)-2-nitrobenzoic acid and its agriculturally acceptable salts thereof, oxyfluorfen (2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene: -lactofen, (1'-(Carboethoxy)ethyl 5-'2-chloro-4-(trifluoromethyl) phenoxyl'-2-nitrobenzoate: imazaquin (2-'4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2--yl'-3-quinolinecarboxylic acid and the agriculturally acceptable salts thereof, N-phosphonomethylglycine or an agriculturally acceptable salt thereof, derivatives thereof, mixtures thereof and the like.

DETAILED DESCRIPTION OF THE INVENTION

The invention herein comprises a herbicidal composition comprising a herbicidally effective amount of a herbicide in particular a herbicide selected from the group consisting of acifluorfen (5-(2-chloro-ααα-trifluoro-p-tolyloxy)-2-nitrobenzoic acid and its agriculturally acceptable salts thereof, (see US Patent 3,979,437); oxyfluorfen (2-chlo- ro-1-(3-ethoxy -4-nitrophenoxy)-4-(trifluoromethyl)benzene: lactofen, (1'-(Carboethoxy)ethyl 5-'2-chloro-4-(trifluoromethyl) phenoxyl'-2-nitrobenzoate: imazaquin (2-'[4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl']-3-quinolinecarboxylic acid and the agriculturally acceptable salts thereof, N-phosphonomethylglycine or an agriculturally acceptable salt thereof, mixtures thereof and the like, inert adjuvant(s), water, humectant, and silicone surfactant.

Herbicide compositions herein include both package and tank mix compositions. The term agriculturally acceptable as employed herein includes agricultural, industrial and residential uses.

Herbicides which are useful in this invention include triazines, ureas, carbamates, acetamides, uracils, acetic acid or phenol derivatives, triazoles, benzoic acids, nitriles, diphenyl ethers and the like such as:

Heterocyclic nitrogen/sulfur derivatives including 2-chloro-4-ethylamino-6-isopropylamino-s-triazine, 2-chloro-4,6-bis(isopropylamino)-s-triazine; 2-chloro-4,6-bis(ethylamine)-s-triazine; 3-isopropyl-1H-2,1,3-benzothiadiazin-4-(3H)-one 2,2-dioxide, 3-amino-1,2,4-triazole; 5-bromo-3-isopropyl-6-methyluracil;

2-(4-isopropyl-4-methyl-5-oxo-2-imdazolin-2-yl-)3-quinolinecarboxylic acid; isopropylamine salt of 2-(4-methyl-5-oxo-2-imidazolin-2-yl)nicotinic acid, methyl 6-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)-m-toluate; and methyl 2-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)-p-toluate; and further including acids/esters/alcohols such as (2, 2-dichloropropionic acid; 2-methyl-4-chlorophenoxyacetic acid, 2,4-dichlorophenoxyacetic acid, methyl-2-[4-(2,4-dichlorophenoxy)phenoxy]propionate, 3-amino-2,5-dichlorobenzoic acid, 2-methoxy-3,6-dichlorobenzoic acid, 2,3,6-trichlorophenylacetic acid, N-1-naphthylphthalamic acid, sodium 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate, 4,6-dinitro-o-sec-butylphenol, butyl 2-[-[(trifluoromethyl)-2-pyridinyl)oxy]-phenoxy]-propanoate; and cyclohexanediones such as sethoxydium and garlon and ethers such as 2,4-dichlorophenyl-4-nitrophenyl ether, 2-chloro-trifuluorop-tolyl-3-ethoxy-4-nitrodiphenyl ether, 5-(2-chloro-4-trifluoromethylphenoxy)-N-methylsulfonyl 2-nitro-benzamide, 1'-(carboethoxy) ethyl 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate and other diphenylethers and other miscellaneous herbicides such as 2,6-dichlorobenzonitrile, monosodium acid methanearsonate, disodium methanearsonate, 2-(2-chlorophenyl)methyl-4,4-dimethyl-3-isoxazolidinone.

Other herbicides useful for practicing the invention herein include fosamine, haloxyfop, imazapyr, mefluidide, metsulfuron, picloram, quizalofop and imidazolinones.

The above compounds are intended merely as representative of the types of compounds which may be employed in this invention. N-phosphonomethylglycine

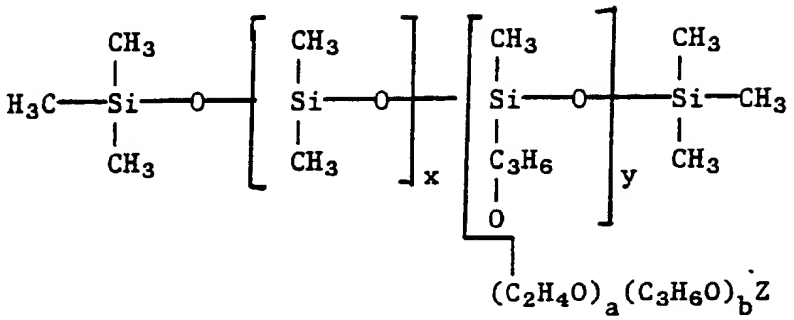
itself may be employed in this invention or optionally any agriculturally acceptable salt, amide, ester, or derivative thereof, mixtures of one or more agriculturally acceptable derivatives or salts or mixtures of an agriculturally acceptable salt and N-phosphonomethylglycine may be employed.

Typical agriculturally acceptable salts which may be employed include those disclosed in US Patents 3,799,758; 4, 405,531; 4,315,765. Preferred salts include the isopropylamine, sodium, ammonium, trimethylsulfonium and guanidine salts. Other compounds further representative of this class of compounds are those herbicidally active compounds disclosed in U.S. Patents Numbers 3, 455,675; 3,799,758; 3,977,860; 3,868,407; 4,315,765 and 4,397,676.

Illustrative suitable humectants which may be employed in this invention includes those compounds which absorb water substantially equivalent to glycerin. Suitable humectants include sorbitol, polyethylene glycol and poly-propylene glycol, propylene glycol, triethylene glycol, glycerin, sodium stearate, microcrystalline cellulose, homolinear polymers of ethylene oxide and soluble collagen, sold under the tradename collasol by Croda Inc., lactic acid and salts thereof, cane molasses, sodium lactate and the like.

Illustrative suitable silicone surfactants useful in this invention comprise organosilicone surfactants and polyaklylene oxide modified dimethylpolysiloxane copolymers which are sold under the trademark Silwet, a trademark of Union Carbide Corporation, U.S.A. These are surface active materials and contain discrete hydrophilic (water-loving) and hydrophobic

(water-hating) segments. These products have the general formula:



(I)

wherein a ranges from 3 to about 24, b ranges from 0 to about 15, x is in the range from 0 to 3 and y ranges from 1 to 5 and in which "Z" can be hydrogen or a lower alkyl radical having 1-3 carbon atoms or an acyl group having 2 to 4 carbon atoms.

Silwet silicone surfactants useful in this invention include those described in a trade brochure by Union Carbide entitled *Silicones For the Agricultural Industry* SUI-356, 6/84, 5M and Surface Active Copolymers also by Union Carbide SUI-394A, 7/85-5M, both of which are incorporated herein in their entirety by reference.

Other suitable illustrative silicone surfactants which may be employed herein include SF-1188 (General Electric Company, Silicone Products Division, Rubber & Fluid Products Department, Waterford, NY 12188), Silwet L-7607, and Dow Corning Corporation, Midland, MI silicone glycols Q2-5309, Q2-5152, Q2-5852 and Q2-5853 mixtures thereof and the like.

Compounds of Formula (I) are particularly described in U.S. Patent 3,299,112 issued to Donald L.

Bailey on January 17, 1967 which is incorporated herein in its entirety by reference. A particularly desired siloxane wetting agent useful herein is shown having the formula $Me_3SiO[MeO(C_2H_4O)_7C_3H_6SiMeO]SiMe_3$.

Also useful herein as a silicone surfactant is a silicone glycol of the average structure

$$Me_3SiO(\underset{\underset{R(OCH_2CH_2)_mOZ}{|}}{\overset{\overset{Me}{|}}{Si}}O)SiMe_3 \qquad (II)$$

wherein Me hereinafter denotes a methyl radical and R is a divalent alkylene group having 2 to 6 carbon atoms, such as ethylene, trimethylene, tetramethylene or hexamethylene. m can be 3 to 24. It is preferred that R is a trimethylene group. In the above formula, Z is selected from the group consisting of hydrogen, an alkyl radical having 1 to 3 carbon atoms and an acyl group having 2 to 4 carbon atoms. Preferably, Z is an acetoxy group.

The silicone glycols described above are known in the art and may be prepared by coupling the corresponding allyl-terminated glycol to a bis-siloxane structure having a hydrogen attached to the central silicon atom, said structure being

$$Me_3SiO(\underset{\underset{H}{|}}{\overset{\overset{Me}{|}}{Si}}O)SiMe_3 \qquad (III)$$

Generally, the coupling is accomplished in the presence of a platinum catalyst. The skilled artisan will recognize that, in such coupling reactions, a

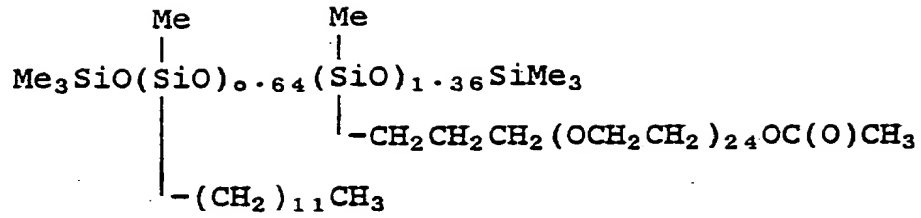
fraction of the allyl-terminated glycol is not converted and will remain as an impurity in the final silicone glycol product. Herbicide compositions may contain such impurities and still be within the scope of the present invention.

Silicone glycol-silicone alkane terpolymers also have utility as a silicone surfactant in the present invention. These compounds may be represented by the average formula

$$QR_2SiO(SiR_2O)_x\left(\begin{matrix}R\\|\\SiO\\|\\A\end{matrix}\right)_y\left(\begin{matrix}R\\|\\SiO\\|\\G\end{matrix}\right)_zSiR_2Q \qquad (IV)$$

wherein R is independently selected from alkyl radicals having 1 to 6 carbon atoms; A is a linear or branched alkyl radical having 7 to 30 carbon atoms; G is a glycol moiety having the formula $-R'(OCH_2CH_2)_mOZ$, in which R' is a divalent alkylene group having 1 to 6 carbon atoms, Z is selected from the group consisting of hydrogen, an alkyl radical having 1 to 3 carbon atoms and an acyl group having 2 to 4 carbon atoms and m is 8 to about 100; Q is independently selected from the group consisting of said alkyl radical A, said glycol moiety G and said alkyl radical R; x is 0 to 100, y is 0.1 to 25 and z is 0.1 to 50.

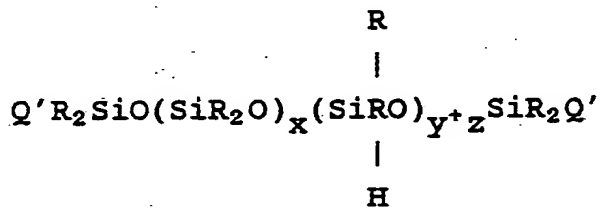
A highly preferred silicone glycol-silicone alkane terpolymer (II) useful in the present invention as a silicone surfactant has the average structure



(V)

wherein Me hereinafter denotes a methyl radical.

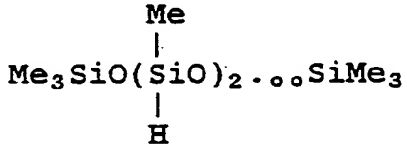
The silicone glycol-silicone alkane terpolymers described above may be prepared by methods well known in the art. Briefly, the corresponding allyl-terminated glycol and alpha-alkene are coupled to an SiH-functional siloxane having the average structure



(VI)

wherein Q' is R or hydrogen and R, x, y and z are as defined in Formula (IV) above.

For the highly preferred silicone glycol-silicone alkane terpolymer described above, 0.77 moles of alpha-dodecene and 1.90 moles of an allyl-terminated glycol having the formula $CH_2=CHCH_2(OCH_2CH_2)_{24}OC(O)CH_3$ are reacted with one mole of an SiH-functional siloxane having the average structure



(VII)

to form one mole of terpolymer product. Coupling is accomplished in the presence of a platinum catalyst at temperatures in the range of about 20 to about 150°C, the reaction preferably being carried out in a solvent such as toluene or isopropanol. Illustrative silicone surfactants prepared and utilized to illustrate this invention are hereinafter referred to as fluids.

In addition to the aforementioned components, the compositions of the present invention may also contain other herbicide adjuvants commonly employed in the art. Examples of such adjuvants include crop oil concentrate, ORTHO X-77 spreader, drift control agents, such as LO-DRIFT, defoaming agents, such as D-FOAMER, compatibility agents, such as E-Z MIX, and other adjuvants well known in the herbicide art.

In order to prepare the compositions of the present invention, from about 0.1 to about 10 parts by weight of the silicone glycol-silicone alkane terpolymer (II) is thoroughly mixed with each part by weight of herbicide (I). Preferably, from 0.5 to about 5 parts by weight of (II) are employed for each part of the pesticide (I). For a given herbicide, the skilled artisan will readily arrive at a herbicidal composition having the optimum ratio of the ingredients by routine experimentation.

The above herbicidal composition may then be dispersed in water and sprayed onto plants according to the method of the present invention, described infra. Alternatively, the silicone glycol-silicone alkane terpolymer adjuvant may be added directly to a water solution or dispersion of herbicide.

The compositions of this invention may be prepared, for example, by starting with a herbicide and adding in any order the various components of the composition of this invention. For example, one may start with a commercial formulation of the isopropylamine salt of N-phosphonomethylglycine which is an aqueous concentrate containing 480 grams per liter of the isopropylamine salt of N-phosphonomethylglycine (41%) by weight.

Thereafter in any order one mixes suitable amounts (a) humectant (b) silicone surfactant and optionally inert adjuvant and adds any diluent water. If desired, one may prepare the composition of this invention by starting with either a herbicide or an agriculturally acceptable salt thereof, or adjuvant, or humectant, or silicone surfactant. Water may be employed if desired in an amount desired.

While the ratios of concentrations of the various components of this invention are hereinafter suggested, those of skill in the art will recognize that minor variations may be necessary to accommodate particular characteristics of acceptable herbicides which may be employed in this invention.

Typically for a herbicide concentrate of this invention, the concentration of herbicide active ingredient will be in the range from about 2 to about 70% by weight and preferably in the range from about 4 to about 40 % by weight of the concentrate.

In a final application solution of the herbicide of this invention as for example in a spray solution applied to foliage, the concentration of herbicide active ingredient will be in the range from

about 0.05% to about 20% by weight and preferably in the range from about 0.15% to about 5% by weight of a final solution illustrative of this invention.

The ratio of herbicidally active ingredient to silicone surfactant will be about the same whether the composition is a concentrate or a spray. Typically, the weight ratio of active ingredient to silicone surfactant is from about 1:30 to about 50:1 and preferably in the range from about 1:15 to about 10:1. The amount of humectant employed in the herbicide formulation is an amount sufficient to overcome (or safen) any antagonism of silicone surfactant toward the herbicide active and/or to improve rainfastness.

The ratio of silicone surfactant to humectant in compositions of this invention will be about the same whether the composition is a concentrate or a spray. Typically, the weight ratio of silicone surfactant to humectant will be in the range from about 1:1 to about 1:200 and preferably in the range from about 1:5 to about 1:50.

Any humectant may be employed in this invention which provides the ability to overcome (or to safen) the antagonism of silicone surfactant toward a herbicide active.

The ratio of herbicide active ingredient to adjuvant will depend to a great deal upon the nature and type of the herbicide active ingredient which is present in the composition. However, typically, the weight ratio of herbicide active ingredient to adjuvant is in the range from about 1:5 to about 10:1 and preferably in the range from about 1:2 to about 4:1.

The amount of water which is employed to prepare the concentrate or final application concentration, as in a spray, is adjusted as necessary. The concentrate and/or final composition may be a dry formulation.

Those of skill in the art will recognize that some departures may be made in the above ranges without significantly affecting the performance of the composition of this invention.

The phytotoxicant compositions of this invention, particularly liquids and soluble powders, preferably contain (in addition to the herbicide active, silicone surfactant, and humectant, an inert adjuvant or conditioning agent), one or more surface-active agents in amounts sufficient to render a given composition readily dispersible in water or in oil. The incorporation of a surface active agent into the compositions of this invention greatly enhances their efficacy. By the term surface active agent, it is understood that wetting agents, dispersing agents , suspending agents and emulsifying agents are included therein. Anionic, cationic and nonionic agents can be employed with equal facility.

Preferred wetting agents are alkyl benzene and alkyl naphthalene sulfonates, sulfated fatty alcohols, amines or acid amides, long chain acid esters of sodium isothionate, esters of sodium sulfosuccinate, sulfated or sulfonated fatty acid esters petroleum sulfonates, sulfonated vegetable oils, ditertiary acetylenic glycols, polyoxyethylene derivatives of alkyl phenols (particularly isooctylphenol and nonylphenol) and polyoxyethylene derivatives of the fatty acid esters of hexito anyhydrides

(sorbitan) Preferred dispersants are methylcellulose, polyvinylalcohol sodium lignin sulfonates, polymeric alky naphthalene sulfonates, sodium naphthalene sulfonate, polymethylene bisnahp- thalenesulfonates and sodium N-methyl-N-long chain acid laurates.

Suitable surfactants (adjuvants) are disclosed in U.S. Patent 3,799,758 and 4,405,531 supra both of which are incorporated herein in their entirety by reference.

A particularly preferred composition of this invention comprises the commercial formulation Roundup herbicide, Silwet L-77, glycerine and diluent water. A particularly preferred method of use of this invention comprises use of that composition as a post emergent herbicide to kill or control rhizone johnsongrass, seedling johnsongrass, barnyard grass and downy brome.

Water dispersible powder compositions can be made containing one or more active ingredients, an inert solid extender and one or more wetting and dispersing agents. The inert solid extenders are usually of mineral origin such as the natural clays, diatomaceous earth and synthetic minerals derived from silica and the like. Examples of such extenders include kaolinites, attapulgite clay and synthetic magnesium silicate. The water dispersible powder of this invention usually contain from about 5 to about 95 parts by weight of active ingredient, from about 0.25 to about 25 parts by weight of wetting agent, from about 0.25 to about 25 parts by weight of dispersant and from about 4.5 to about 94.5 parts by weight of inert solid extender, all parts being by weight of the total composition. Where required, from

about 0.1 to about 2.0 parts by weight of the solid inert extender can be replaced by a corrosion inhibitor or antifoaming agent or both.

Aqueous suspensions can be prepared by mixing together and grinding an aqueous slurry of water-insoluble active ingredient in the presence of dispersing agents to obtain a concentrated slurry of very finely divided particles. The resulting concentrated aqueous suspension is characterized by its extremely small particle size so that when diluted and sprayed, coverage is very uniform.

Although composition of this invention can also contain other additaments, for example fertilizers, phytotoxicants and plant growth regulants, herbicides and the like used as adjuvants or in combination with any of the above described adjuvants, it is preferred to employ the compositions of this invention along with sequential treatments with other phytotoxicants, fertilizers and the like for maximum effect. Composition of this invention can also be admixed with other material fertilizers, phytotoxicants and applied in a single application. Chemicals useful in combination with the active ingredients of this invention either simultaneously or sequentially including for example triazine, ureas,, carbamates, acetamides, uracils, acetic acids, phenols, thiocarbamates, triazoles, benzoic acids, nitriles and the like.

When practicing this invention, effective amounts of herbicide for example, amounts of herbicide which kill or control plants, further for example effective amounts of N-phosphonomethylglycine or agriculturally acceptable salts thereof or derivatives

are applied to above ground portions of plants (foliage in particular). The application of liquid and particulate solid herbicidal compositions to above ground portions of plants can be carried out by conventional methods, e.g. boom and hand application including sprayers or dusters. The composition can also be applied aerially as spray if desired.

The application of an effective amount of the herbicide composition of this invention to selected locus such as a plant foliage is essential for the practice of this invention. The amount of herbicide active ingredient to be employed is dependent upon the response desired in the plant as well as such other factors as the plant species and stage of development thereof, the amount of rainfall as well as the specific herbicide employed. It is believed that one skilled in the art can readily determine from the teachings of this specification including examples, the approximate application rate.

GENERAL PROCEDURE FOR EXAMPLES 1-34

The following weed species were used as indicator weeds:

Common Name	Scientific Name
Seedling johnsongrass	Sorghum halepense
Rhizome johnsongrass	Sorghum halepense
Downy Brome	Bromus tectorum
Barnyardgrass	Echinochloa crus-galli
Velvetleaf	Abutilon theophrasti
Yellow nutsedge	Cyperus esculentus
Crabgrass	Digitarias sp.
Cocklebur	Xanthium pennsylvanicum
Redroot Pigweed	Amaranthus retroflexus

The narrowleaf and broadleaf test weeds were seeded separately into plastic pots 4 inches in diameter and 3 inches deep with drainage holes on the bottom. The pots contained Dupo silt loam soil obtained from the St. Charles Research Farm of Monsanto Company located in St. Charles, Missouri. Prior to use, the soil was steam sterilized at a temperature of 180 Degrees Fahrenheit. The soil used was either mixed with a slow release 14-14-14 fertilizer so as to prefertilize it or in some cases where the soil was not prefertilized, the soil was fertilized with a 5% commercial Rapid-Gro fertilizer solution via sub-irrigation 3 to 5 days prior to treating the plants in the pots with the chemical compositions.

Seedling johnsongrass, barnyardgrass, downy brome, velvetleaf, crabgrass, cocklebur and redroot pigweed were started from seeds, rhizome johnsongrass

plants were grown from rhizome pieces and yellow nutsedge from tubers. In all cases, sufficient seeds or stock propagules were planted to produce several seedlings in each pot. Approximately 7 to 10 days after seeding, the velvetleaf, cocklebur and redroot pigweed seedlings were thinned out leaving 2 to 3 healthy seedlings per pot.

After the pots were seeded, the pots were moved into the greenhouse and placed on trays with each tray holding 40 to 60 pots. The trays were lined with absorbent mats for sub-irrigation. The greenhouse temperature was maintained at 86 Degrees Fahrenheit during the day and 70 Degrees Fahrenheit during the night. Photoperiod in the greenhouse was maintained at 14 to 16 hours daylength using supplemental lighting. The seeded pots were watered via subirrigation as required.

Depending on the weed species used in a given test, the chemical treatments were applied within 14 to 21 days after planting. At that time, the narrowleaf weeds were approximately 4 to 16 inches tall while the broadleaf weeds were 1 to 4 inches tall.

Chemical treatments were applied post-emergence with the foliage of the weeds as the locus of application using a tract sprayer equipped with a single 8001E spray nozzle. The sprayer was previously calibrated to deliver a spray volume equivalent to about 20 gallons per acre of spray solution at a spraying pressure of about 30 psi.

The chemical compositions illustrative of compositions of this invention used in the tests were

formulated as tank mixtures the same day of application. The formulations comprised an agriculturally acceptable salt of N-phosphonomethylglycine namely the isopropylamine salt, an inert adjuvant as a surfactant, a humectant, an organosilicone surface active copolymer and water.

Rates of application based on N-phosphonomethyglycine ranged from about 1/8 to about 3 pounds glyphosate acid equivalent per acre. The ingredient ratios employed in the formulations were glyphosate to surfactant, about 1:0.125 to 1:1, surfactant to silicone 1:0.45 to 1:20, silicon surfactant to humectant about 1:1 to about 1:200. Rainfall treatment was applied one hour after spraying of the compositions using a rain tower calibrated to deliver approximately 1/4 inch of simulated rainfall within a period of about 15 minutes.

After application of rainfall, the treated plants were placed on carts and moved into the greenhouse. After the plants had sufficiently dried out, the pots were returned to the greenhouse trays and arranged in a randomized complete block experimental design. Each treatment contained 3 replications. Control plants and appropriate standard treatments were provided in each test. A duplicate set of plants which received the same treatment and treated in a similar manner as the rainfall treated plants were also provided for comparison under no rain condition.

Observations on the effects of the treatments were taken within 7 to 10 days for early burndown effects and again within 21 to 28 days after treatment for longer term effects. A rating scale of 0% to 100% was used in estimating the degree of weed

control with 0% having no observable effect and 100% as complete kill of the weed. The degree of burn, chlorosis, necrosis, stature reduction, and other observable effects of the treatments on plant species present in the test were taken into consideration in making the ratings.

Although the invention is described with respect to specific modifications, the details thereof are not to be construed as limitations.

Examples which follow illustrate compositions and method of use of this invention. Within some of these Examples, there is comparative data obtained therewith in various columns and lines for compositions typical of prior art tank mixes comprising Roundup® herbicide with L-77 added, Roundup® herbicide without added Silwet L-77 and Roundup® herbicide with glycerin (but no added silicone surfactant). In these examples, a.e. acid equivalent means acid equivalent of glyphosate acid (N-phosphonomethylglycine).

EXAMPLE 1.

Response of rhizome johnsongrass to Roundup and Roundup + L-77 tank mixture under no rain condition and after simulated rainfall and mist treatments applied one hour after application of herbicide treatment. Data show average percent growth inhibition at 14 and 28 days after treatment.

Treatment		Roundup Rate (lb ae/A) 0.25	0.75	Mean
		14 Days After Treatment		
Roundup	No Rainfall	10	92	51
	1/4" Rainfall	3	15	9
	Light Mist	7	87	47
Roundup + 1% L-77	No Rainfall	2	25	12
	1/4" Rainfall	10	38	24
	Light Mist	8	77	42
		28 Days After Treatment		
Roundup	No Rainfall	33	91	62
	1/4" Rainfall	10	38	24
	Light Mist	18	97	58
Roundup + 1% L-77	No Rainfall	10	28	22
	1/4" Rainfall	22	48	35
	Light Mist	28	88	53

EXAMPLE 2.

Response of rhizome johnsongrass to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Glycerin at different concentrations of glycerin in the spray mixture in the absence of simulated rainfall treatment. Data show average percent growth inhibition at 28 days after treatment.

Treatment	Roundup Rate (lb ae/A) 0.25	0.5	0.75	Mean
Roundup	60	97	88	82
Roundup + 1% L-77	20	35	63	39
Roundup + 1% L-77 + 1% Glycerin	43	58	71	58
Roundup + 1% L-77 + 3% Glycerin	35	78	77	63
Roundup + 1% L-77 + 5% Glycerin	72	88	92	84
Roundup + 1% Glycerin	60	100	100	87
Roundup + 3% Glycerin	62	100	100	87
Roundup + 5% Glycerin	55	100	100	85

EXAMPLE 3

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Glycerin at different Glycerin concentration in the spray mixture with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. All treatments contained Roundup at 1/2 lb ae/A.

Treatment	Rainfall	Average % Inhibition 7 DAT	21 DAT
Roundup	None	75	100
	1/4"	17	53
Roundup + 1% L-77	None	23	45
	1/4"	28	63
Roundup + 1% L-77 + 1% Glycerin	None	18	45
	1/4"	60	93
Roundup + 1% L-77 + 2% Glycerin	None	33	66
	1/4"	58	99
Roundup + 1% L-77 + 5% Glycerin	None	82	96
	1/4"	52	92
Roundup + 1% L-77 + 10% Glycerin	None	93	100
	1/4"	82	99

EXAMPLE 4.

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Propylene Glycol in the spray mixture with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. All treatments contained Roundup at 1/2 lb ae/A.

Treatment	Rainfall	Average % Inhibition 7 DAT	21 DAT
Roundup	None	75	100
	1/4"	17	53
Roundup + 1% L-77	None	23	45
	1/4"	28	63
Roundup + 1% L-77 + 1% Propylene Glycol	None	28	83
	1/4"	37	83
Roundup + 1% L-77 + 2% Propylene Glycol	None	63	95
	1/4"	42	90

EXAMPLE 5.

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + Silicone surfactant and Roundup + Silicone surfactant + Glycerin with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 23 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	None	45	99	72
	1/4"	5	72	38
Roundup + 0.25% L-77	None	3	25	14
	1/4"	3	72	38
Roundup + 0.25% L-77 + 10% Glycerin	None	98	100	99
	1/4"	88	98	93
Roundup + 1% L-77	None	5	30	18
	1/4"	18	78	48
Roundup + 1% L-77 + 10% Glycerin	None	80	99	90
	1/4"	37	97	67
Roundup + 0.25% SF-1188	None	7	96	52
	1/4"	5	72	38
Roundup + 0.25% SF-1188 + 10% Glycerin	None	94	100	97
	1/4"	53	96	74
Roundup + 1% SF-1188	None	20	96	58
	1/4"	10	43	26
Roundup + 1% SF-1188 + 10% Glycerin	None	97	100	98
	1/4"	85	100	92
Roundup + 10% Glycerin	None	57	100	78
	1/4"	0	40	20

EXAMPLE 6.

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + PEG-200 with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 21 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	None	17	100	58
	1/4"	0	88	44
Roundup + 0.25% L-77	None	3	22	13
	1/4"	0	83	42
Roundup + 0.25% L-77 + 5% PEG-200	None	43	99	71
	1/4"	77	98	88
Roundup + 0.25% L-77 + 10% PEG-200*	None	95	100	97
	1/4"	68	100	84
Roundup + 0.50% L-77	None	8	20	14
	1/4"	18	68	43
Roundup + 0.50% L-77 + 5% PEG-200	None	12	82	47
	1/4"	42	96	69
Roundup + 0.50% L-77 + 10% PEG-200	None	80	100	90
	1/4"	80	99	90
Roundup + 1% L-77	None	22	50	36
	1/4"	42	77	59
Roundup + 1% L-77 + 5% PEG-200	None	17	50	33
	1/4"	80	100	90
Roundup + 1% L-77 + 10% PEG-200	None	50	97	74
	1/4"	65	98	82

* $HO(CH_2CH_2O)_nH$

$n \sim 4.5$

EXAMPLE 7

Response of rhizome johnsongrass to Roundup and tank mixtures containing Roundup + Silicone SF-1188 as a silicone surfactant and Roundup + SF-1188 + Glycerin at different glycerin concentrations in the spray mixture with and without rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 21 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.25	0.75	Mean
Roundup	None	15	98	56
	1/4"	2	23	12
Roundup + 1% SF-1188*	None	8	85	47
	1/4"	2	7	4
Roundup + 1% SF-1188 + 1.25% Glycerin	None	28	82	55
	1/4"	0	52	26
Roundup + 1% SF-1188 + 2.5% Glycerin	None	82	97	89
	1/4"	22	80	51
Roundup + 1% SF-1188 + 5% Glycerin	None	97	99	98
	1/4"	83	98	91
Roundup + 1% SF-1188 + 10% Glycerin	None	97	100	98
	1/4"	77	94	85

* SF-1188 is a silicone fluid comprising a copolymer of a polydimethylsiloxane and a polyoxyalkylene ether made and sold by General Electric Company, Silicone Products Division, Waterford, NY 12188.

EXAMPLE 8.

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + L-7607 and Roundup + L-7607 + Glycerin with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 21 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	None	0	98	49
	1/4"	7	83	45
Roundup + 1% L-7607	None	12	48	31
	1/4"	27	87	57
Roundup + 1% L-7607 + 1% Glycerin	None	37	52	44
	1/4"	27	67	47
Roundup + 1% L-7607 + 3% Glycerin	None	43	97	70
	1/4"	38	88	63
Roundup + 1% L-7607 + 5% Glycerin	None	63	100	82
	1/4"	90	95	93
Roundup + 1% L-7607 + 10% Glycerin	None	93	100	97
	1/4"	83	98	91

EXAMPLE 9.

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + SF-1188 and Roundup + SF-1188 + Glycerin with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 21 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	None	0	98	49
	1/4"	7	83	45
Roundup + 1% SF-1188	None	0	33	17
	1/4"	13	76	45
Roundup + 1% SF-1188 + 1% Glycerin	None	3	59	31
	1/4"	55	87	71
Roundup + 1% SF-1188 + 3% Glycerin	None	95	96	96
	1/4"	58	99	79
Roundup + 1% SF-1188 + 5% Glycerin	None	100	95	97
	1/4"	93	100	97
Roundup + 1% SF-1188 + 10% Glycerin	None	93	100	97
	1/4"	99	100	100

EXAMPLE 10

Response of yellow nutsedge to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Glycerin with and without rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 28 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 1.0	2.0	3.0	Mean
Roundup	None	50	77	85	71
	1/4"	23	47	73	47
Roundup + 0.25% L-77	None	45	67	96	69
	1/4"	45	82	57	61
Roundup + 0.25% L-77 + 2.5% Glycerin	None	70	88	90	82
	1/4"	52	58	73	61
Roundup + 0.25% L-77 + 5% Glycerin	None	57	85	99	80
	1/4"	57	67	72	65
Roundup + 0.25% L-77 + 10% Glycerin	None	65	74	78	72
	1/4"	47	95	65	69
Roundup + 1% L-77	None	65	75	87	76
	1/4"	60	73	73	69
Roundup + 1% L-77 + 2.5% Glycerin	None	67	84	80	77
	1/4"	58	70	79	69
Roundup + 1% L-77 + 5% Glycerin	None	70	88	90	83
	1/4"	53	63	90	69
Roundup + 1% L-77 + 10% Glycerin	None	89	93	99	94
	1/4"	77	63	92	77

EXAMPLE 11

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Sorbitol with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 23 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	None	12	97	54
	1/4"	5	63	34
Roundup + 0.25% L-77	None	3	7	5
	1/4"	3	17	10
Roundup + 0.25% L-77 + 5% Sorbitol	None	23	93	58
	1/4"	13	85	49
Roundup + 0.25% L-77 + 10% Sorbitol	None	27	100	63
	1/4"	23	94	59
Roundup + 10% Sorbitol*	None	32	98	65
	1/4"	7	20	13

* $CH_2OH-(CHOH)_4-CH2OH$

EXAMPLE 12.

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Glycerin at different concentrations of L-77 and glycerin in the spray mixture with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 24 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	None	15	98	56
	1/4"	10	87	48
Roundup + 0.05% L-77	None	12	38	25
	1/4"	17	35	26
Roundup + 0.05% L-77 + 2.5% Glycerin	None	87	99	93
	1/4"	72	100	86
Roundup + 0.05% L-77 + 5% Glycerin	None	98	98	98
	1/4"	85	100	92
Roundup + 0.05% L-77 + 10% Glycerin	None	94	99	97
	1/4"	93	95	94
Roundup + 0.10% L-77	None	8	8	8
	1/4"	13	84	49
Roundup + 0.10% L-77 + 2.5% Glycerin	None	79	100	89
	1/4"	7	83	45
Roundup + 0.10% L-77 + 5% Glycerin	None	98	99	99
	1/4"	63	99	81
Roundup + 0.10% L-77 + 10% Glycerin	None	90	99	95
	1/4"	82	98	90
Roundup + 0.30% L-77	None	7	18	13
	1/4"	17	87	52
Roundup + 0.30% L-77 + 2.5% Glycerin	None	20	88	54
	1/4"	18	65	42
Roundup + 0.30% L-77 + 5% Glycerin	None	86	99	93
	1/4"	15	98	57
Roundup + 0.30% L-77 + 10% Glycerin	None	97	99	98
	1/4"	52	99	75

EXAMPLE 13

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + Silicone and Roundup + Silicone surfactant + Glycerin with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 21 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	None	2	98	60
	1/4"	0	5	3
Roundup + 0.25% L-77	None	0	5	3
	1/4"	0	0	0
Roundup + 0.25% L-77 + 10% Glycerin	None	98	100	99
	1/4"	93	97	95
Roundup + 1% L-77	None	3	55	29
	1/4"	15	28	22
Roundup + 1% L-77 + 10% Glycerin	None	78	100	89
	1/4"	67	100	83
Roundup + 0.25% L-7607	None	0	12	6
	1/4"	0	2	1
Roundup + 0.25% L-7607 + 10% Glycerin	None	98	100	99
	1/4"	77	98	88
Roundup + 1% L-7607	None	0	32	16
	1/4"	0	8	4
Roundup + 1% L-7607 + 10% Glycerin	None	97	100	99
	1/4"	78	95	87
Roundup + 0.25% SF-1188 Silicone surfactant	None	0	13	7
	1/4"	0	0	0

	Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
5	Roundup + 0.25% SF-1188 + 10% Glycerin	None	92	100	96
		1/4"	10	65	38
	Roundup + 1% SF-1188	None	0	15	8
		1/4"	0	0	0
	Roundup + 1% SF-1188	None	95	99	97
10	+ 10% Glycerin	1/4"	33	97	65
	Roundup + 10% Glycerin	None	45	100	72
		1/4"	0	8	4

EXAMPLE 14.

Response of downy brome to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Glycerin with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 28 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.375	0.75	1.5	Mean
Roundup	None	15	75	100	63
	1/4"	0	5	13	6
Roundup + 0.25% L-77	None	13	94	92	66
	1/4"	3	7	8	6
Roundup + 0.25% L-77 + 2.5% Glycerin	None	95	99	100	98
	1/4"	5	18	72	32
Roundup + 0.25% L-77 + 5% Glycerin	None	97	99	99	98
	1/4"	17	38	56	37
Roundup + 0.25% L-77 + 10% Glycerin	None	97	88	99	95
	1/4"	58	42	70	57
Roundup + 1% L-77	None	23	23	72	39
	1/4"	0	2	2	1
Roundup + 1% L-77 + 2.5% Glycerin	None	53	92	91	79
	1/4"	7	2	12	7
Roundup + 1% L-77 + 5% Glycerin	None	95	100	99	98
	1/4"	3	22	40	22
Roundup + 1% L-77 + 10% Glycerin	None	93	100	100	98
	1/4"	23	28	73	42

EXAMPLE 15.

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Humectant with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 22 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	None	8	99	54
	1/4"	3	32	18
Roundup + 0.25% L-77	None	13	3	8
	1/4"	0	18	9
Roundup + 0.25% L-77 + 5% Glycerin	None	93	99	96
	1/4"	58	97	78
Roundup + 0.25% L-77 + 5% Dextrose	None	53	99	76
	1/4"	15	85	50
Roundup + 0.25% L-77 + 5% Sodium Lactate*	None	97	100	98
	1/4"	3	47	25
Roundup + 0.25% L-77 + 5% Lactic Acid*	None	52	97	74
	1/4"	7	22	14
Roundup + 0.25% L-77 + 5% Triethylene Glycol	None	91	99	95
	1/4"	91	98	95
Roundup + 0.25% L-77 + 5% PEG-200	None	91	99	96
	1/4"	57	99	78
Roundup + 0.25% L-77 + 5% Cane Molasses*	None	12	5	8
	1/4"	15	30	23
Roundup + 5% Dextrose	None	13	97	55
	1/4"	5	10	8

* Humectants

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup + 5% Sodium Lactate	None	75	100	88
	1/4"	2	27	14
Roundup + 5% Lactic Acid	None	40	82	61
	1/4"	0	33	17
Roundup + 5% Triethylene Glycol	None	67	99	83
	1/4"	0	10	5
Roundup + 5% PEG-200	None	62	99	80
	1/4"	2	25	13
Roundup + 5% Cane Molasses	None	5	2	3
	1/4"	5	2	3

EXAMPLE 16.

Response of seedling johnsongrass to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + humectant at different concentrations of L-77 and humectant in the spray mixture without simulated rainfall treatment. Data show average percent growth inhibition at 21 days after treatment.

Treatment	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	62	98	80
Roundup + 0.01% L-77	13	97	55
Roundup + 0.01% L-77 + 0.25% Glycerin	5	77	41
Roundup + 0.01% L-77 + 0.50% Glycerin	10	90	50
Roundup + 0.01% L-77 + 1.00% Glycerin	25	97	61
Roundup + 0.01% L-77 + 0.25% TEG*	12	83	47
Roundup + 0.01% L-77 + 0.50% TEG	12	93	52
Roundup + 0.01% L-77 + 1.00% TEG	42	88	65
Roundup + 0.025% L-77	3	68	36
Roundup + 0.025% L-77 + 0.025% Glycerin	2	45	23
Roundup + 0.025% L-77 + 0.50% Glycerin	2	57	29
Roundup + 0.025% L-77 + 1.00% Glycerin	15	78	46
Roundup + 0.025% L-77 + 0.25% TEG	2	43	23
Roundup + 0.025% L-77 + 0.50% TEG	0	55	28
Roundup + 0.025% L-77 + 1.00% TEG	13	77	45
Roundup + 0.05% L-77	2	28	15
Roundup + 0.05% L-77 + 0.50% Glycerin	0	8	4
Roundup + 0.05% L-77 + 1.00% Glycerin	2	35	18
Roundup + 0.05% L-77 + 2.50% Glycerin	58	73	66
Roundup + 0.05% L-77 + 0.50% TEG	0	13	7
Roundup + 0.05% L-77 + 1.00% TEG	0	33	17
Roundup + 0.05% L-77 + 2.50% TEG	25	75	50

* Triethylene glycol

	Treatment	Roundup Rate (lb ae/A) 0.125	0.375	Mean
5	Roundup + 0.10% L-77	3	13	8
	Roundup + 0.10% L-77 + 0.50% Glycerin	2	8	5
	Roundup + 0.10% L-77 + 1.00% Glycerin	2	15	8
	Roundup + 0.10% L-77 + 2.50% Glycerin	52	92	72
	Roundup + 0.10% L-77 + 0.50% TEG	7	2	4
10	Roundup + 0.10% L-77 + 1.00% TEG	3	2	3
	Roundup + 0.10% L-77 + 2.50% TEG	27	78	53

EXAMPLE 17

Response of cocklebur to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Glycerin with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 22 days after treatment.

Treatment	Rainfall	Roundup Rate (lb ae/A) 0.0625	0.1875	0.3125	Mean
Roundup	None	60	100	100	87
	1/4"	0	33	57	30
Roundup + 0.25% L-77	None	43	95	99	79
	1/4"	30	80	75	62
Roundup + 0.25% L-77 + 5% Glycerin	None	80	95	100	92
	1/4"	55	83	100	79

EXAMPLE 18.

Response of crabgrass and pigweed to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Glycerin in the absence of simulated rainfall treatment. Data show average percent growth inhibition at 20 days after treatment.

Treatment	Glyphosate Rate (lb ae/A)	Average % Inhibition	
		Crabgrass	Pigweed
Roundup	0.0625	20	0
	0.1875	96	100
	0.3125	98	100
	0.4375	100	100
	Mean	76	75
Roundup + 0.25% L-77	0.0625	0	75
	0.1875	33	100
	0.3125	72	100
	0.4375	78	100
	Mean	46	94
Roundup + 0.25% L-77 + 5% Glycerin	0.0625	67	100
	0.1875	97	95
	0.3125	100	100
	0.4375	100	100
	Mean	91	99

EXAMPLE 19.

Response of downy brome and velvetleaf to Roundup and tank mixtures containing Roundup + L-77 and Roundup + L-77 + Glycerin with and without simulated rainfall treatment. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. Data show average percent growth inhibition at 23 days after treatment.

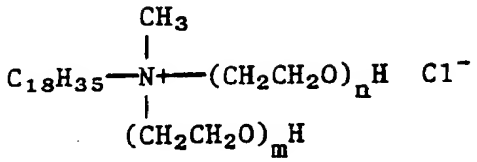
Treatment	Weed Species	Rainfall	Roundup Rate (lb ae/A) 0.3125	0.4375	Mean
Roundup	Downy Brome	None	83	93	88
		1/4"	68	63	66
	Velvetleaf	None	50	77	63
		1/4"	0	2	1
Roundup + 0.25% L-77	Downy Brome	None	63	82	72
		1/4"	47	77	62
	Velvetleaf	None	80	80	80
		1/4"	90	90	90
Roundup + 0.25% L-77 + 5% Glycerin	Downy Brome	None	100	100	100
		1/4"	99	100	100
	Velvetleaf	None	47	97	72
		1/4"	98	98	98

EXAMPLE 20

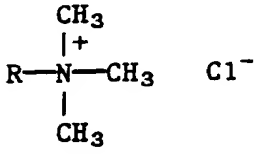
Response of seedling johnsongrass to glyphosate formulations containing quaternary ammonium surfactants at different glyphosate to surfactant ratios with and without L-77 and/or glycerin and in the absence of simulated rainfall treatment. Data show average growth inhibition at 21 days after treatment.

Treatment	Roundup Rate (lb ae/A) 0.125	0.375	Mean
Roundup	85	99	93
Roundup + 0.25% L-77	20	63	42
Roundup + 0.25% L-77 + 5% Glycerin	97	100	98
MON-0139/MON-0818*** (2:1)	78	99	89
MON-0139/MON-0818 + 0.25% L-77	15	86	51
MON-0139/MON-0818 + 0.25% L-77 + 5% Glycerin	93	98	96
MON-0139/MON-0818 (4:1)	73	99	86
MON-0139/MON-0818 + 0.25% L-77	18	47	32
MON-0139/MON-0818 + 0.25% L-77 + 5% Glycerin	94	100	97
MON-0139/MON-0818 (8:1)	37	100	68
MON-0139/MON-0818 + 0.25% L-77	10	38	24
MON-0139/MON-0818 + 0.25% L-77 + 5% Glycerin	99	100	100
MON-0139/Arquad* T50 (2:1)	87	100	93
MON-0139/Arquad T50 + 0.25% L-77	17	76	46
MON-0139/Arquad T50 + 0.25% L-77 + 5% Glycerin	99	100	99
MON-0139/Arquad T50 (4:1)	90	100	95
MON-0139/Arquad T50 + 0.25% L-77	13	53	33
MON-0139/Arquad T50 + 0.25% L-77 + 5% Glycerin	98	100	99
MON-0139/Arquad T50 (8:1)	43	100	72
MON-0139/Arquad T50 + 0.25% L-77	10	43	27
MON-0139/Arquad T50 + 0.25% L-77 + 5% Glycerin	98	100	99
MON-0139/Ethoquad** O-25 (2:1)	72	99	86
MON-0139/Ethoquad O-25 + 0.25% L-77	18	84	51
MON-0139/Ethoquad O-25 + 0.25% L-77 + 5% Glycerin	62	100	81
MON-0139/Ethoquad O-25 (4:1)	48	98	73
MON-0139/Ethoquad O-25 + 0.25% L-77	18	33	26
MON-0139/Ethoquad O-25 + 0.25% L-77 + 5% Glycerin	95	100	98

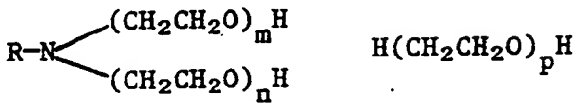
Treatment	Roundup Rate (lb ae/A) 0.125	0.375	Mean
MON-0139/Ethoquad O-25 (8:1)	20	99	59
MON-0139/Ethoquad O-25 + 0.25% L-77	7	33	20
MON-0139/Ethoquad O-25 + 0.25% L-77 + 5% Glycerin	99	100	99

Formula * = 

m + n total 15

Formula ** = 

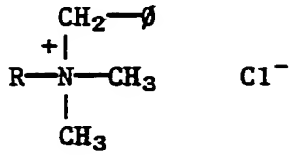
R is from tallow

Formula *** = 

m+n+p ≈ 20

R is from tallow

Treatment	Roundup Rate (lb ae/A) 0.125	0.375	Mean
MON-0139/Arquad B-100* (2:1)	74	100	87
MON-0139/Arquad B-100 + 0.25% L-77	27	85	56
MON-0139/Arquad B-100 + 0.25% L-77 + 5% Glycerin	93	99	96
MON-0139/Arquad B-100 (4:1)	77	100	88
MON-0139/Arquad B-100 + 0.25% L-77	25	73	49
MON-0139/Arquad B-100 + 0.25% L-77 + 5% Glycerin	99	100	100
MON-0139/Arquad B-100 (8:1)	33	100	67
MON-0139/Arquad B-100 + 0.25% L-77	23	73	48
MON-0139/Arquad B-100 + 0.25% L-77 + 5% Glycerin	99	100	100

* = 

R = fatty acid

EXAMPLE 21.

Response of velvetleaf to glyphosate formulations containing quaternary ammonium surfactants at different glyphosate to surfactant ratios with and without L-77 and/or glycerin and in the absence of simulated rainfall treatment. Data show average growth inhibition at 21 days after treatment.

Treatment	Roundup Rate (lb ae/A) 0.3125	0.50	Mean
Roundup	27	77	52
Roundup + 0.25% L-77	72	87	79
Roundup + 0.25% L-77 + 5% Glycerin	68	94	81
MON-0139/MON-0818 (2:1)	38	75	57
MON-0139/MON-0818 + 0.25% L-77	68	82	75
MON-0139/MON-0818 + 0.25% L-77 + 5% Glycerin	83	91	87
MON-0139/MON-0818 (4:1)	23	70	47
MON-0139/MON-0818 + 0.25% L-77	68	87	78
MON-0139/MON-0818 + 0.25% L-77 + 5% Glycerin	77	87	82
MON-0139/MON-0818 (8:1)	20	68	44
MON-0139/MON-0818 + 0.25% L-77	73	87	80
MON-0139/MON-0818 + 0.25% L-77 + 5% Glycerin	73	87	80
MON-0139/Arquad T50 (2:1)	25	78	52
MON-0139/Arquad T50 + 0.25% L-77	25	58	42
MON-0139/Arquad T50 + 0.25% L-77 + 5% Glycerin	73	93	83
MON-0139/Arquad T50 (4:1)	3	72	38
MON-0139/Arquad T50 + 0.25% L-77	55	75	65
MON-0139/Arquad T50 + 0.25% L-77 + 5% Glycerin	65	88	77
MON-0139/Arquad T50 (8:1)	5	60	32
MON-0139/Arquad T50 + 0.25% L-77	60	77	68
MON-0139/Arquad T50 + 0.25% L-77 + 5% Glycerin	75	83	79
MON-0139/Ethoquad O-25 (2:1)	15	80	48
MON-0139/Ethoquad O-25 + 0.25% L-77	52	73	62
MON-0139/Ethoquad O-25 + 0.25% L-77 + 5% Glycerin	77	88	82
MON-0139/Ethoquad O-25 (4:1)	12	68	40
MON-0139/Ethoquad O-25 + 0.25% L-77	62	77	69
MON-0139/Ethoquad O-25 + 0.25% L-77 + 5% Glycerin	77	85	81

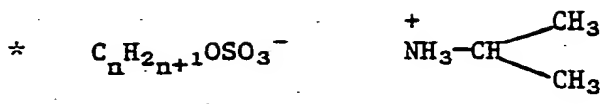
Treatment	Roundup Rate (lb ae/A) 0.3125	0.50	Mean
MON-0139/Ethoquad O-25 (8:1)	7	47	27
MON-0139/Ethoquad O-25 + 0.25% L-77	73	90	82
MON-0139/Ethoquad O-25 + 0.25% L-77 + 5% Glycerin	75	86	81
MON-0139/Arquad B-100 (2:1)	18	62	40
MON-0139/Arquad B-100 + 0.25% L-77	63	68	66
MON-0139/Arquad B-100 + 0.25% L-77 + 5% Glycerin	77	87	82
MON-0139/Arquad B-100 (4:1)	2	53	28
MON-0139/Arquad B-100 + 0.25% L-77	82	78	80
MON-0139/Arquad B-100 + 0.25% L-77 + 5% Glycerin	62	83	72
MON-0139/Arquad B-100 (8:1)	3	63	33
MON-0139/Arquad B-100 + 0.25% L-77	60	90	75
MON-0139/Arquad B-100 + 0.25% L-77 + 5% Glycerin	67	78	72

EXAMPLE 22.

The effect of different surfactant types on the efficacy and rainfastness of glyphosate + L-77 + glycerin tank mixtures on seedling johnsongrass and barnyardgrass. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. All treatments contained glyphosate at 3/8 lb ae/A. Data show average percent growth inhibition at 27 days after treatment.

Treatment	Rainfall	Seedling johnsongrass	Barnyardgrass
		Average % Inhibition	
Roundup	None	100	73
	1/4"	23	30
Roundup + 0.25% L-77	None	84	65
	1/4"	0	17
Roundup + 0.25% L-77 + + 5% Glycerin	None	99	90
	1/4"	85	89
MON-0139 + 0.09% MON-0818	None	100	94
	1/4"	40	23
MON-0139 + 0.09% MON-0818 + 0.25% L-77	None	68	50
	1/4"	3	13
MON-0139 + 0.09% MON-0818 + 0.25% L-77+ 5% Glycerin	None	100	97
	1/4"	97	97
MON-0139 + 0.09% Witconate X-7163*	None	85	69
	1/4"	13	23
MON-0139 + 0.09% Witconate X-7163 + 0.25% L-77	None	15	12
	1/4"	17	20
MON-0139 + 0.09% Witconate X-7163 + 0.25% L-77 + 5% Glycerin	None	100	95
	1/4"	90	80
MON-0139 + 0.09% Ethoquad** C/12	None	100	100
	1/4"	80	50
MON-0139 + 0.09% Ethoquad C/12 + 0.25% L-77	None	40	65
	1/4"	27	32

wherein Witconate X-7163 is of the formula



wherein n = 8 to 10

Treatment	Rainfall	Seedling johnsongrass	Barnyardgrass
		Average % Inhibition	
MON-0139 + 0.09% Ethoquad C/12 + 0.25% L-77 + 5% Glycerin	None	100	99
	1/4"	100	85
MON-0139 + 0.09% Sorpol 8227	None	100	87
	1/4"	17	12
MON-0139 + 0.09% Sorpol 8227 + 0.25% L-77	None	42	30
	1/4"	8	3
MON-0139 + 0.09% Sorpol 8227 + 0.25% L-77 + 5% Glycerin	None	93	98
	1/4"	91	74
MON-0139 + 0.09% Ethomeen C/12	None	98	94
	1/4"	27	17
MON-0139 + 0.09% Ethomeen C/12 + 0.25% L-77	None	38	70
	1/4"	13	5
MON-0139 + 0.09% Ethomeen C/12 + 0.25% L-77 + 5% Glycerin	None	100	100
	1/4"	97	85
MON-0139 + 0.09% Igepal CA-720	None	98	88
	1/4"	68	60
MON 0139 + 0.09% Igepal CA-720 + 0.25% L-77	None	12	5
	1/4"	13	10
MON-0139 + 0.09% Igepal CA-720 + 0.25% L-77 + 5% Glycerin	None	100	95
	1/4"	97	91
MON-0139 + 0.09% Nonylphenol blend	None	100	94
	1/4"	30	23
MON-0139 + 0.09% Nonylphenol blend + 0.25% L-77	None	3	12
	1/4"	18	13

Treatment	Rainfall	Seedling johnsongrass	Barnyardgrass
		Average % Inhibition	
MON-0139 + 0.09% Nonylphenol blend + 0.25% L-77 + 5% Glycerin	None	100	98
	1/4"	87	70
MON-0139 + 0.09% Sterox NJ	None	100	91
	1/4"	0	0
MON-0139 + 0.09% Sterox NJ + 0.25% L-77	None	28	10
	1/4"	0	0

Igepal CA-720 = C_8H_{17}——O——$(CH_2CH_2O)_{12.5}H$

Sterox NJ = C_9H_{19}——O——$(CH_2CH_2O)_{9.5}H$

Sorpol 8227 = mix of $C_{12}H_{25}—N^+(CH_2CH_2OH)_2(CH_3)$ Cl^-

with alkyl phenol ethoxylate

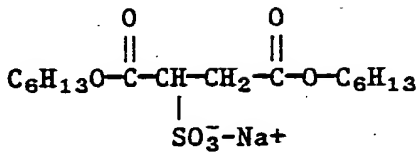
Ethoquad C/12 is $R—N^+(CH_2CH_2OH)_2(CH_3)$ Cl^- where

R is from coco fatty acid.

Ethomeen C/12 is $R—N(CH_2CH_2OH)_2$ where

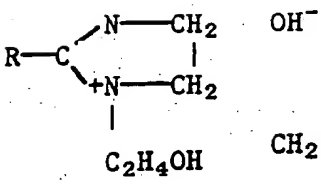
R is from coco fatty acid.

Treatment	Rainfall	Seedling johnsongrass	Barnyardgrass
		Average % Inhibition	
MON-0139 + 0.09% Sterox NJ + 0.25% L-77 + 5% Glycerin	None	100	90
	1/4"	90	86
MON-0139 + 0.09% Miranol CM-SFK	None	100	99
	1/4"	0	13
MON-0139 + 0.09% Miranol CM-SFK + 0.25% L-77	None	62	32
	1/4"	0	0
MON-0139 + 0.09% Miranol CM-SFK + 0.25% L-77 + 5% Glycerin	None	98	76
	1/4"	95	62
MON-0139 + 0.09% Aerosol MA-80	None	53	27
	1/4"	0	0
MON-0139 + 0.09% Aerosol MA-80 + 0.25% L-77	None	20	28
	1/4"	0	0
MON-0139 + 0.09% Aerosol MA-80 + 0.25% L-77 + 5% Glycerin	None	100	88
	1/4"	100	78
MON-0139 + 0.09% Frigate	None	100	95
	1/4"	45	43
MON-0139 + 0.09% Frigate + 0.25% L-77	None	73	78
	1/4"	10	8
MON-0139 + 0.09% Frigate + 0.25% L-77 + 5% Glycerin	None	100	93
	1/4"	85	98

Aerosol MA-80 is 

Frigate is a based adjuvant tallow amine ethoxylate.

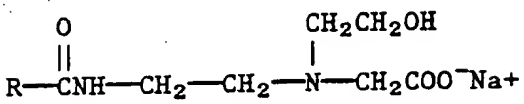
Miranol CM-SFK



where

CH_2COO^-Na+

R is a coco Fatty acid or



EXAMPLE 23

The effect of different glyphosate salts on the efficacy and rainfastness of glyphosate + L-77 + glycerin tank mixtures on seedling johnsongrass and barnyardgrass. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. All treatments contained glyphosate at 3/8 lb ae/A. Data show average percent growth inhibition at 27 days after treatment.

Treatment	Rainfall	Seedling johnson-grass	Barnyard-grass
		Average % Inhibition	
Roundup	None	100	88
	1/4"	17	25
Roundup + 0.25% L-77	None	50	33
	1/4"	8	17
Roundup + 0.25% L-77 + 5% Glycerin	None	100	94
	1/4"	97	87
Sodium Glyphosate + 0.09% MON-0818	None	98	80
	1/4"	45	27
Sodium Glyphosate + 0.09% MON-0818 + 0.25% L-77	None	42	37
	1/4"	10	3
Sodium Glyphosate + 0.09% MON-0818 + 0.25% L-77+ 5% Glycerin	None	100	92
	1/4"	99	80
Potassium Glyphosate + 0.09% MON-0818	None	99	83
	1/4"	48	28
Potassium Glyphosate + 0.09% MON-0818 + 0.25% L-77	None	62	55
	1/4"	7	13
Potassium Glyphosate + 0.09% MON-0818 + 0.25% L-77 + 5% Glycerin	None	100	73
	1/4"	96	90
Copper Glyphosate + 0.09% MON-0818	None	97	70
	1/4"	3	10
Copper Glyphosate + 0.09% MON-0818 + 0.25% L-77	None	12	22
	1/4"	7	3

Treatment	Rainfall	Seedling johnsongrass	Barnyardgrass
		Average % Inhibition	
Copper Glyphosate + 0.09% MON-0818 + 0.25% L-77 + 5% Glycerin	None	100	72
	1/4"	96	67
IPA Glyphosate + 0.09% MON-0818	None	100	78
	1/4"	35	48
IPA Glyphosate + 0.09% MON-0818 + 0.25% L-77	None	58	38
	1/4"	15	22
IPA Glyphosate + 0.09% MON-0818 + 0.25% L-77 + 5% Glycerin	None	100	88
	1/4"	88	80
Ammonium Glyphosate + 0.09% MON-0818	None	100	89
	1/4"	32	38
Ammonium Glyphosate + 0.09% MON-0818 + 0.25% L-77	None	88	81
	1/4"	7	23
Ammonium Glyphosate + 0.09% MON-0818 + 0.25% L-77 + 5% Glycerin	None	100	88
	1/4"	86	82

EXAMPLE 24

The effect of different humectants on the efficacy and rainfastness of glyphosate + L-77 tank mixtures on seedling johnsongrass and barnyardgrass. Simulated rainfall equivalent to 1/4 inch of rain was applied approximately one hour after application of herbicide treatments. All treatments contained glyphosate at 3/8 lb ae/A. Data show average percent growth inhibition at 26 days after treatment.

Treatment	Rainfall	Seedling johnsongrass	Barnyardgrass
		Average % Inhibition	
Roundup	None	100	90
	1/4"	50	30
MON-0139 + 0.09% MON-0818	None	100	63
	1/4"	37	27
MON-0139 + 0.09% MON-0818 + 0.25% L-77	None	97	73
	1/4"	7	17
MON-0139 + 0.09% MON-0818 + 0.25% L-77 + 5% Glycerin	None	100	89
	1/4"	100	81
MON-0139 + 0.09% MON-0818 + 0.25% L-77 + 5% Dipropylene glycol	None	69	50
	1/4"	27	30
MON-0139 + 0.09% MON-0818 + 0.25% L-77 + 5% Ethylene glycol	None	57	47
	1/4"	25	17
MON-0139 + 0.09% MON-0818 + 0.25% L-77 + 5% Butanol	None	96	62
	1/4"	32	30
MON-0139 + 0.09% MON-0818 + 0.25% L-77 + 5% Glucose	None	99	98
	1/4"	93	68
MON-0139 + 0.09% MON-0818 + 0.25% L-77 + 5% Fructose	None	100	86
	1/4"	96	62
MON-0139 + 0.09% MON-0818 + 0.25% L-77 + 5% Sucrose	None	100	84
	1/4"	85	67

MON-0139 is an aqueous concentrate comprising the isopropylamine salt of N-phosphonomethylglycine and water, about 62% isopropylamine salt by weight.

MON-0818 is an ethoxylated tallow amine useful as a surfactant.

EXAMPLE 25

Response of seedling johnsongrass, barnyardgrass and velvetleaf to tank mixtures containing ammonium glyphosate and L-77 with low level of glycerin for efficacy and rainfastness. Simulated rainfall equivalent to 1/4 inch of rainfall was applied approximately one hour after application of herbicide treatments. All treatments contained glyphosate at 3/8 lb ae/A. Data show average percent growth inhibition at 28 days after treatment.

Treatment	Rainfall	Seedling johnsongrass	Barnyardgrass	Velvetleaf
		Average % Inhibition		
Roundup	None	100	100	99
	1/4"	33	38	0
Roundup + 0.25% L-77	None	25	42	100
	1/4"	20	23	100
Roundup + 0.25% L-77 + 1% Glycerin	None	47	90	100
	1/4"	60	73	97
Roundup + 0.25% L-77 + 5% Glycerin	None	100	98	100
	1/4"	100	100	100
Ammonium Glyphosate + 0.09% MON-0818	None	98	100	92
	1/4"	22	25	0
Ammonium Glyphosate + 0.09% MON-0818 + 0.25% L-77	None	35	55	100
	1/4"	13	10	100
Ammonium Glyphosate + 0.09% MON-0818 + 0.25% L-77 + 1% Glycerin	None	87	92	100
	1/4"	33	58	100
Ammonium Glyphosate + 0.09% MON-0818 + 0.25% L-77 + 5% Glycerin	None	100	100	100
	1/4"	100	100	87

Treatment	Rainfall	Seedling johnson-grass	Barnyard-grass	Velvet-leaf
		Average % Inhibition		
Ammonium Glyphosate + 0.09% Ethoquad C/12	None	100	100	72
	1/4"	17	17	0
Ammonium Glyphosate + 0.09% Ethoquad C/12 + 0.25% L-77	None	30	48	100
	1/4"	32	22	88
Ammonium Glyphosate + 0.09% Ethoquad C/12 + 0.25% L-77 + 1% Glycerin	None	65	95	100
	1/4"	15	18	100
Ammonium Glyphosate + 0.09% Ethoquad C/12 + 0.25% L-77 + 5% Glycerin	None	100	100	100
	1/4"	97	92	75

EXAMPLE 26.

Response of certain broadleaf weeds to postemergence treatments of herbicide tank mixtures containing acifluorfen (Blazer® herbicide) + L-77 + Glycerin. Data show average percent growth inhibition at 21 days after treatment.

Treatment	Herbicide Rate (lb ai/A)	Cocklebur	Morningglory	Velvetleaf	Hemp Sesbania
Blazer herbicide	0.125	0	0	0	20
	0.375	3	0	0	33
Blazer + 0.5% Triton AG-98	0.125	2	0	0	47
	0.375	17	3	10	97
Blazer + 0.5% Triton AG-98 + 0.5% L-77	0.125	25	55	20	47
	0.375	37	67	27	100
Blazer + 0.5% Triton AG-98 + 0.5% L-77 + 10% Glycerin	0.125	17	47	27	72
	0.317	37	100	88	97
Blazer + 0.5% L-77	0.125	10	33	20	28
	0.375	25	68	87	100
Blazer + 0.5% L-77 + 10% Glycerin	0.125	17	0	33	27
	0.375	80	98	80	77
Blazer + 0.5% X-45 + 10% Glycerin	0.125	20	23	20	57
	0.375	20	43	48	100
Blazer + 0.5% X-45* + 0.5% L-77 + 10% Glycerin	0.125	7	20	17	48
	0.375	18	78	63	97
Blazer + 0.5% Triton AG-98 + 0.5% Igepal CA-210 + 10% Glycerin	0.125	5	3	0	32
	0.375	17	12	32	53
Blazer + 0.5% L-77 + 0.5% Igepal CA-630 + 10% Glycerin	0.125	30	27	23	37
	0.375	48	87	53	100

* X-45, Blazer + humectant only

Triton AG-98 = Tank mix adjuvant, 80% alkylaryl polyoxyethylene glycols

Triton X-45 = C_8H_{17}——O——$(CH_2CH_2O)_5H$

Igepal CA-630 = C_8H_{17}——O——$(CH_2CH_2O)_9H$

Igepal CA-210 = C_8H_{17}——O——$(CH_2CH_2O)_{1.5}H$

EXAMPLE 27.

Response of seedling johnsongrass and barnyardgrass to postemergence treatments of herbicide tank mixtures containing imazaquin (Scepter® herbicide) + L-77 + Glycerin. Scepter was applied at 0.375 lb ai per acre. Data show average percent growth inhibition at 21 days after treatment. (a.i. means active ingredient.)

Treatment	Seedling johnsongrass	Barnyard-grass
Scepter herbicide	27	27
Scepter + L-77	47	50
Scepter + L-77 + Glycerin	57	53
Scepter + Triton X-45 + Glycerin	63	47

EXAMPLE 28

Response of barnyardgrass to tank mixtures containing Roundup®, Silicone Fluid and glycerin in the absence or presence of 1/4 inch simulated rainfall applied one hour after treatment. Roundup® was applied at 3/8 lb ae/A, Fluid at 0.25% (v/v), and glycerin at 2.5% (v/v). The spray gallonage was equivalent to 20 gallons per acre of spray solution.

Treatment	Average % Inhibition (25 DAT) 0 Rain - Glycerin	0 Rain + Glycerin	1/4" Rain - Glycerin	1/4" Rain + Glycerin
Roundup	95	100	12	8
Roundup + Fluid 3	20	87	0	57
Roundup + Fluid 7	40	100	0	72
Roundup + Fluid 8	40	99	2	68
Roundup + Fluid 4	100	99	3	73
Roundup + Fluid 6	100	100	30	72
Roundup + Fluid 10	100	100	5	64

where fluids are defined hereinafter and are useful as Silicone surfactants herein.

- means without
+ means with

EXAMPLE 29.

Response of barnyardgrass to tank mixtures containing Roundup®, Fluid and glycerin in the absence or presence of 1/4 inch simulated rainfall applied one hour after treatment. Data show average percent growth inhibition 27 days after treatment. Roundup® was applied at 3/8 lb ae/A, Fluid at 0.25% (v/v), and glycerin at 5% (v/v). The spray gallonage was equivalent to 20 gallons per acre of spray solution.

	Average % Inhibition (25 DAT)			
	0 Rain		1/4" Rain	
Treatment	- Glycerin	+ Glycerin	- Glycerin	+ Glycerin
Roundup	100	99	27	27
Roundup + Fluid 1	100	100	50	98
Roundup + Fluid 5	100	100	5	100

EXAMPLE 30.

Response of barnyardgrass to tank mixtures containing Roundup®, Fluid and glycerin in the absence or presence of 1/4 inch simulated rainfall applied one hour after treatment. Data show average percent growth inhibition 23 days after treatment. Roundup® was applied at 3/8 lb ae/A, Fluid at 0.5% (v/v), and glycerin at 5% (v/v). The spray gallonage was equivalent to 20 gallons per acre of spray solution.

Treatment	Average % Inhibition (25 DAT) 0 Rain	1/4" Rain
Roundup	96	3
Roundup + Glycerin	94	3
Roundup + Fluid 9	86	0
Roundup + Fluid 9 + Glycerin	100	85

EXAMPLE 31.

Response of barnyardgrass to tank mixtures containing Roundup®, Fluid and glycerin in the absence or presence of 1/4 inch simulated rainfall applied one hour after treatment. Data show average percent growth inhibition 24 days after treatment. Roundup® was applied at 1/2 lb ae/A, Fluid at 1% (v/v). The spray gallonage was equivalent to 20 gallons per acre of spray solution.

Treatment	Average % Inhibition (25 DAT) 0 Rain	1/4" Rain
Roundup	100	23
Roundup + Fluid 6	100	63
Roundup + Fluid 6 + 1% Glycerin	100	53
Roundup + Fluid 6 + 3% Glycerin	100	86
Roundup + Fluid 6 + 5% Glycerin	100	95

EXAMPLE 32.

Response of barnyardgrass to tank mixtures containing Roundup®, Fluid and glycerin in the absence or presence of 1/4 inch simulated rainfall applied one hour after treatment. Data show average percent growth inhibition 26 days after treatment. Roundup® was applied at 3/8 lb ae/A, Fluid at 0.25% (v/v). The spray gallonage was equivalent to 20 gallons per acre of spray solution.

Treatment	Average % Inhibition (25 DAT) 0 Rain	1/4" Rain
Roundup	98	3
Roundup + Fluid 2	73	3
Roundup + Fluid 2 + 1% Glycerin	98	40
Roundup + Fluid 2 + 2.5% Glycerin	86	63
Roundup + Fluid 2 + 5% Glycerin	88	98
Roundup + 5% Glycerin	85	3

EXAMPLE 33.

Response of rhizome johnsongrass to tank mixtures containing Roundup®, Fluid and glycerin in the absence or presence of 1/4 inch simulated rainfall applied one hour after treatment. Data show average percent growth inhibition 23 days after treatment. Roundup® was applied at 3/8 lb ae/A and glycerin at 1% (v/v). The spray gallonage was equivalent to 20 gallons per acre of spray solution.

Treatment	Average % Inhibition (25 DAT) 0 Rain	1/4" Rain
Roundup	53	8
Roundup + 0.125% Fluid 6 + Glycerin	100	73
Roundup + 0.25% Fluid 6 + Glycerin	100	100
Roundup + 1% Fluid 6 + Glycerin	100	93
Roundup + 1% Fluid 6	99	76

EXAMPLE 34.

Response of rhizome johnsongrass to tank mixtures containing Roundup®, Fluids and glycerin in the absence or presence of 1/4 inch simulated rainfall applied one hour after treatment. Data show average percent growth inhibition 22 days after treatment. Roundup® was applied at 1/2 lb ae/A and Fluids 0.5% (v/v). The spray gallonage was equivalent to 20 gallons per acre of spray solution.

Silicone Additive	Glycerin Con. (%)	Average % Inhibition (25 DAT) 0 Rain	1/4" Rain
NONE	-	95	27
Fluid 11	0	52	68
	0.5	80	43
	1	48	58
	2	76	67
	5	100	89
Fluid 7	0	13	5
	0.5	65	15
	1	98	43
	2	98	77
Fluid 8	0	18	7
	0.5	45	20
	1	72	45
	2	99	78
Fluid 6	0	90	73
	0.5	99	88
	1	99	91
	2	100	98
Fluid 10	0	92	60
	0.5	96	80
	1	99	93
	2	99	97

Note:

Glycerin concentration is expressed as % of the total spray volume based on a spray gallonage equivalent to 20 galons/A.

Fluid 11 is a material of Formula IV wherein Q and R are both methyl, x and y are both zero, G is $-CH_2CH_2CH_2(OCH_2CH_2)_7OC{=}OMe$ and z is 1.

FLUIDS

$Me_3SiO(SiMe_2O)_x(SiMeAO)_y(SiMeGO)_zSiMe_3$

FLUID	ALKANE CHAIN LENGTH	ALKANE UNITS (y)	EO UNITS (m)	GLYCOL UNITS (z)	DIMETHYL UNITS (x)
1	16	0.90	12	4.60	8.5
2	12	1.32	12	2.68	2.0
3	12	0.50	4	5.00	8.5
4	12	1.50	24	2.50	2.0
5	12	0.64	7	1.36	0.0
6	12	0.64	24	1.36	0.0
7	12	0.50	4	3.50	2.0
8	12	0.25	4	1.75	0.0
9	12	2.00	12	9.00	19.0
10	12	1.00	24	4.50	8.5

all wherein G is $-CH_2CH_2CH_2(OCH_2CH_2)_mOC{=}OMe$

WHAT IS CLAIMED IS:

1. An enhanced herbicidal composition comprising a herbicidally effective amount of a herbicide, humectant, and silicone surfactant.

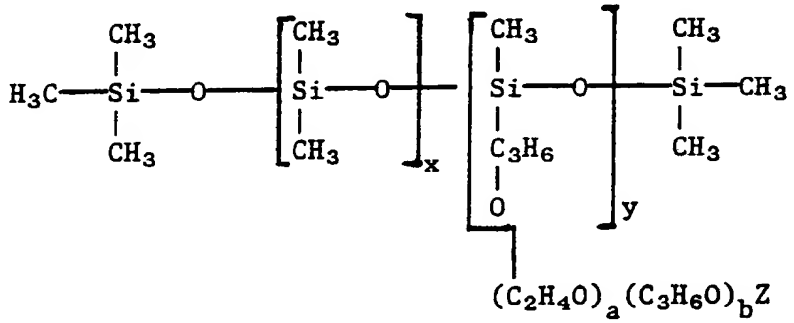
2. The herbicide composition of Claim 1 wherein said herbicide is selected from the group consisting of acifluorfen (5-(2-chloro-ααα-trifluoro-p-tolyloxy)-2-nitrobenzoic acid and its agriculturally acceptable salts thereof; oxyfluorfen (2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene: lactofen, (1'-(Carboethoxy)ethyl 5-'2-chloro-4-(trifluoromethyl)phenoxyl'-2-nitrobenzoate: imazaquin (2-'4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2- yl'-3-quinolinecarboxylic acid and the agriculturally acceptable salts thereof, N-phosphonomethylglycine and/or an agriculturally acceptable salt thereof, mixtures thereof and the like.

3. The herbicide composition of Claim 2, wherein said herbicide is N-phosphonomethylglycine or an agriculturally acceptable salt thereof.

4. The herbicide composition of Claim 3, wherein said agriculturally acceptable salt of N-phosphonomethylglycine is the isopropylamine salt.

5. The herbicide composition of Claim 3, which comprises the isopropylamine salt of N-phosphonomethylglycine, Silwet L-77, and humectant.

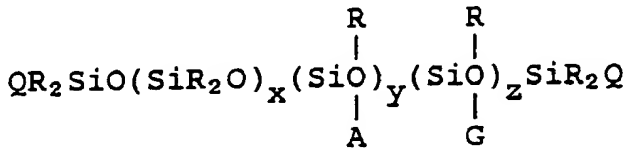
6. The herbicidal composition of Claim 1 wherein said silicone surfactant comprises a polyalkylene oxide modified dimethylpolysiloxanes copolymer(s) having the average general formula:



wherein a ranges from 3 to about 24, b ranges from 0 to about 15, x is in the range from about 0 to 3 and y ranges from 1 to 5 and in which "Z" can be hydrogen or a lower alkyl radical having 1-3 carbon atoms or an acyl group having 2 to 4 carbon atoms.

7. The herbicidal composition of claim 6, wherein a ranges from 4 to 7, b ranges from 0 to 3, x = 0 and y = 1.

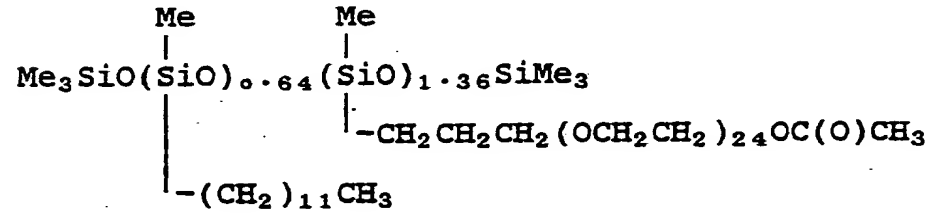
8. The herbicidal composition of claim 1, wherein said silicone surfactant is a compound of the Formula



wherein R is independently selected from alkyl radicals having 1 to 6 carbon atoms; A is a linear or branched alkyl radical having 7 to 30 carbon atoms; G is a glycol moiety having the formula $-R'(OCH_2CH_2)_mOZ$,

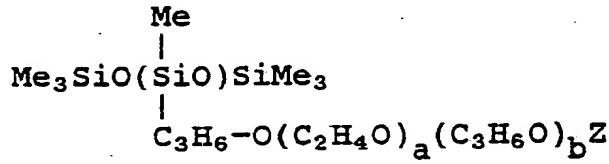
in which R' is a divalent alkylene group having 1 to 6 carbon atoms, Z is selected from the group consisting of hydrogen, an alkyl radical having 1 to 3 carbon atoms and an acyl group having 2 to 4 carbon atoms and m is 8 to about 100; Q is independently selected from the group consisting of said radical A, said glycol moiety G and said alkyl radical R; x is 0 to 100, y is 0.1 to 25 and z is 0.1 to 50.

9. The herbicidal composition of claim 8, wherein said silicone surfactant is a compound of the average Formula



wherein Me denotes a methyl radical.

10. The composition of claim 1, wherein said herbicide is N-phosphonomethylglycine or an agriculurally acceptable salt thereof and said silicone surfactant is selected from the group consisting of those having the average formula



(III)

wherein Me is a methyl radical, a is from 4 to 7, b is 0 to 3 and Z is selected from the group of hydrogen, alkyl radical having 1 to 3 carbon atoms or an acyl group having 2 to 4 carbon atoms and those

having the average formula

$$Q(R_2)SiO(SiR_2O)_x\left(\begin{matrix}R\\|\\SiO\\|\\A\end{matrix}\right)_y\left(\begin{matrix}R\\|\\SiO\\|\\G\end{matrix}\right)_zSiR_2Q \qquad (IV)$$

wherein R is independently selected from alkyl radicals having 1 to 6 carbon atoms; A is a linear or branched alkyl radical having 7 to 30 carbon atoms; G is a glycol moiety having the formula $-R'(OCH_2CH_2)_mOZ$, in which R' is a divalent alkylene group having 1 to 6 carbon atoms, Z is selected from the group consisting of hydrogen, an alkyl radical having 1 to 3 carbon atoms and an acyl group having 2 to 4 carbon atoms and m is 8 to about 100; Q is independently selected from the group consisting of said radical A, said glycol moiety G and said alkyl radical R; x is 0 to 100, y is 0.1 to 25 and z is 0.1 to 50.

11. The herbicidal composition of claim 10, wherein said silicone surfactant comprises those having the average formula

$$Me_3SiO\left(\begin{matrix}Me\\|\\SiO\\|\\C_3H_6-O(C_2H_4O)_a(C_3H_6O)_bZ\end{matrix}\right)SiMe_3 \qquad (III)$$

wherein Me is a methyl radical, a is from 4 to 7, b is 0 to 3 and Z is selected from the group of hydrogen, alkyl radical having 1 to 3 carbon atoms or an acyl group having 2 to 4 carbon atoms.

12. The herbicidal composition of claim 10, wherein said agriculturally acceptable salt of

N-phosphonomethylglycine is an amine, trimethylsulfonium, or an iminourea salt.

13. The herbicidal composition of claim 10, wherein said agriculturally acceptable salt of N-phosphonomethgylglycine is the isopropylamine salt.

14. The herbicidal composition of Claim 7, wherein said humectant is selected from the group consisting of sorbitol, glycerol, polyethylene glycol, polypropylene glycol, propylene glycol, triethylene glycol, glycerine, sodium stearate, microcrystalline cellulose, homolinear polymers of ethylene oxide, soluble collagen, lactic acid and salts thereof, cane molasses and the like.

15. The herbicidal composition of Claim 7, wherein the concentration of active ingredient is in the range from about 2 to about 70% by weight.

16. The herbicidal composition of Claim 12, wherein the concentration of said active ingredient is in the range from about 4 to about 40% by weight.

17. The herbicidal composition of Claim 13, wherein in a final application solution, the concentration of said active ingredient is in the range from about 0.05% to about 20% by weight.

18. The composition of Claim 14, wherein in a final application solution to be made on foliage, the concentration of said active ingredient is in the range from about 0.15% to about 5% by weight.

19. The composition of Claim 14, wherein the ratio of active ingredient to silicone surfactant is about 1:1.

20. The composition of Claim 16, wherein the ratio of active ingredient to silicone surfactant is in that range from about 1:30 to about 50:1.

21. The composition of Claim 17, wherein the weight ratio of active ingredient to silicone surfactant is in the range from about 1:15 to about 10:1.

22. The composition of Claim 16, wherein the ratio of silicone surfactant to humectant is about the same.

23. The composition of Claim 19, wherein the weight ratio of silicone surfactant to humectant is in the range from about 1:1 to about 1:200.

24. The composition of Claim 20, wherein the weight ratio of silicone surfactant to humectant is in the range from about 1:5 to about 1:50.

25. The composition of Claim 19, wherein the weight ratio of active ingredient to adjuvant is in the range from about 1:5 to about 10:1.

26. The composition of Claim 22, wherein the weight ratio of active ingredient to adjuvant is in the range from about 1:2 to about 4:1.

27. A composition of Claim 1, which further comprises inert adjuvants and water.

28. The composition of Claim 1, wherein said composition is a dry composition.

29. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 1.

30. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 2 .

31. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 3 .

32. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 4 .

33. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 5 .

34. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 6 .

35. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 7 .

36. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 8 .

37. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 9 .

38. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 10 .

39. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 11 .

40. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 12 .

41. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 13 .

42. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 14 .

43. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 15 .

44. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 16 .

45. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 17 .

46. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 18 .

47. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 19 .

48. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 20 .

49. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 21 .

50. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 22 .

51. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 23 .

52. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 24 .

53. A herbicidal method of use for killing or controlling weeds which comprises contacting a plant with an effective amount of the composition of Claim 25 .

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 89/02570

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: A 01 N 25/30, A 01 N 57/20

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	A 01 N

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	FR, A, 2589328 (STAUFFER CHEMICAL CO.) 7 May 1987 see page 1, lines 25-29; page 3, lines 13-29; page 3, line 37 - page 4, line 2; claims & AU, A, 64552/86 (cited in the application) --	1-53
Y	DE, A, 1950380 (DOW CORNING CORP.) 23 April 1970 see claims 1,8,9 & GB, A, 1225249 (cited in the application)	1-53

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* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
4th October 1989	26. 10. 89
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	T.K. WILLIS

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 8902570 SA 29746

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 24/10/89
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A- 2589328	07-05-87	AU-B- 586293	06-07-89
		AU-A- 6455286	07-05-87
		DE-A- 3636994	07-05-87
		JP-A- 62120304	01-06-87
DE-A- 1950380	23-04-70	AT-A- 300451	15-06-72
		BE-A- 740113	10-04-70
		CH-A- 533945	28-02-73
		FR-A- 2020409	10-07-70
		GB-A- 1255249	01-12-71
		NL-A- 6915346	14-04-70